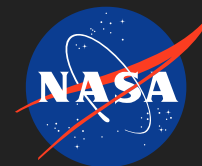


Inverse Finite Method Investigation for Adaptive Structures (iFEM)

Completed Technology Project (2012 - 2016)



Project Introduction

This research project is evaluating an innovative technique that uses fiber optic strain sensors to measure structural deformations and full field strains. An inverse finite element method (iFEM) analysis reconstructs a deformed structural shape based on the strain measurement data simulated by FEM analysis to represent the *in-situ* strain measurements. By mapping the iFEM displacement solution onto a full FEM model, without the applied loading, the complete fields of displacement, strain, and stress are reconstructed to a high degree of accuracy. This project supports the work on multiple flight research projects at NASA Armstrong.

Work to date: The team has completed and validated a 1-dimensional beam element test using a compliant slider mechanism.

Looking ahead: Future plans involve developing and validating the algorithm on a full size flight test article.

Benefits

- **Accurate:** Algorithm is capable of accurate full-field structural shape and strain measurement
- **Economical:** Uses a minimum number of sensors to recreate the full-field structural deformations and strains
- **Improves safety:** Enables more efficient health monitoring of control surfaces and flexible structures

Applications

- Aircraft wing flaps
- Helicopter blades
- Motor vehicles
- Trains
- Ships and submersibles
- Wind turbines

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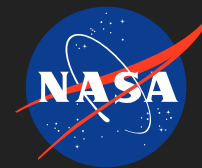
Looking ahead: Future plans involve developing and validating the algorithm



NASA Flight Test Research Project - one of the applications of the inverse finite element method (iFEM) analysis

Table of Contents

Project Introduction	1
Anticipated Benefits	2
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Images	3
Technology Maturity (TRL)	3
Technology Areas	3



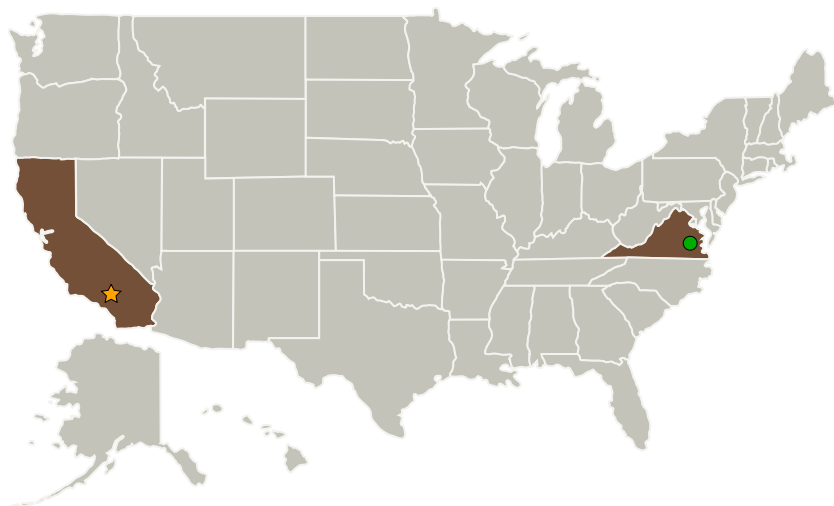
on a full size flight test article.

Anticipated Benefits

This technology is being explored on NASA funded projects for deformation and full field strain measurement. It provides the following benefits:

- **Accurate:** Algorithm is capable of accurate full-field structural shape and strain measurement
- **Economical:** Uses a minimum number of sensors to recreate the full-field structural deformations and strains
- **Improves safety:** Enables more efficient health monitoring of control surfaces and flexible structures

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Innovation Fund: AFRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

David F Voracek

Principal Investigator:

Eric J Miller

Co-Investigator:

Alexander Tessler

Inverse Finite Method Investigation for Adaptive Structures (iFEM)

Completed Technology Project (2012 - 2016)



Primary U.S. Work Locations

California

Virginia

Images

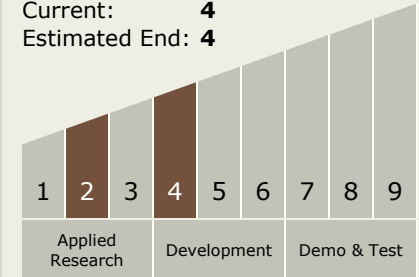


NASA Flight Test Research Project

NASA Flight Test Research Project - one of the applications of the inverse finite element method (iFEM) analysis
(<https://techport.nasa.gov/image/6557>)

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - TX12.3 Mechanical Systems
 - TX12.3.4 Reliability, Life Assessment, and Health Monitoring